Royal School of Mines, Jermyn-Street.

MR. WARINGTON SMYTH'S LECTURES.

[FROM NOTES BY OUR REPORTER.]

LECTURE XX.—So large a proportion of the cost of mining depended on the payments for labour, that that was the most important item for consideration in mining economy. The simple way of payment, as in ordinary labour, by the day had been proved to be unsatisfactory in mining. The men being employed underground, where there could not be any real supervision, it was found that the proper amount of labour was not done for the money. In Cornwall this was so well understood that those men who worked at so much per diem were called "owner's account men," and were looked on with a little contempt by the other miners. There was no doubt in mining that the best mode of payment was that which was measured by the work done, and as the men had great opportunities for observation with respect to the changes and prospects of a lode or seam, that faculty, as well as their industry, was stimulated. Nevertheless, the adventurers could not always escape from paying by the day, and this especially where the work was not established, where the ground was doubtful, and interruptions took place, and where, in consequence, it would be scarcely fair to the men to make a bargain the conditions of which might alter from day to day. Again, the labourers in the mine, whose occupation was merely to assist the miners, were paid by the day. Those who did the "tramming" were sometimes paid in this way, as well as the carpenters, smiths, and enginemen; but the greater part of these classes of workmen were better paid by the bargain, if the terms could be properly arranged. Although there was a general resemblance, the practical differences were so great that no rules of payment would be applicable to metalliferous mines and collieries alike, although the principal officers in both cases were paid by the day, or month, or year; but the hewers and putters should be paid according to what they effected. Sometimes men were paid by the day, and had to bore so many holes for their day's work; but it was difficult for the overseer in every case to see whether the holes were bored or not. This plan, therefore, was not desirable unless the overseer could get readily at the work, and see that the holes were properly placed, and bored to the requisite depth. In some hard quarries in Wales the borers were paid so much an inch when the ground was extremely stiff, and large charges were to be used, and the overseer went round at stated times, and gauged the holes; but in underground workings, where the men were scattered all over the place, such a plan would require almost as many superintendents as there were men. In metalliferous mines there were various kinds of work, and the nature of each was pretty well represented by their names. Sometimes the works were let on a long bargain, a very wide sort of contract, by which the whole or a large part of a mine was let to a company of men called "tributers," to do the best, they could for a considerable period, and sometimes for a twelvemonth. This was done in lead mines, but it was considered to have had such mischievous results that now in most leases there was a covenant inserted not to sublet without the consent of the landlord. It was a sort of arrangement which exposed the workmen to the temptation of working out every bit of ore, and ruining that part of the mine. All bargains, therefore, should be limited by such conditions as would enable the master to direct the general features of the mine, bringing to bear on definite portions of the works such regulations as would keep the energies and interests of the men in subordination to that great object. MR. SMYTH then passed on to what were called "tutwork" bargains, from the German word "todtwork," or dead work, which related to the preliminary operations in a mine, or when what was produced did not pay. Sometimes the bargain was by the fathom, and was called in the North "fathom-tale." The men took a piece of ground through which a shaft was to pass or a level to be driven, and arranged for the work to be done in a certain time for a certain sum. Generally speaking, the bargain was for the work to be paid for every month or two months, though in some cases the payment was delayed for a longer period, which was not so well either for the men or the masters; at the same time, too frequent payments were objectionable. If, for instance, the pay should be weekly a great deal of time would be lost in the actual routine of the pay, and the men would lose much time in holiday-making and marketing. On the whole, therefore, the fortnightly system was found to be the shortest time at which it was advisable to pay, and this was a practice frequently adopted in the coal districts, while in metalliferous mines the period was usually either one month or two. In some cases lump bargains were made, by which men sunk a certain distance for a certain set price. In all these bargains there were certain circumstances which should be looked to in determining the terms on which the work was to be performed; for instance, the dimension of the level or shaft, the hardness of the rock, the degree of jointiness or divisional planes running through it, the nearness or remoteness of the miners' dwellings, as, of course, those who had to expend much muscular force in walking to their labour must be expected to do a less amount of work. It was usual for the owner to find powder, safety-fuses, tools, &c., to be accounted for out of the round sum for which the bargain was made, and sometimes a deduction was agreed upon for the doctor's fund, the club fund, and other like provisions for sickness, accidents, and occasionally for the education of the children. When the terms were agreed upon, and the men were at work, close inspection was needed from time to time to see that the horizontal direction of the level was not departed from. There was a great tendency in the men when working certain sorts of ground to rise too rapidly, and a great deal of grumbling would be saved if by an early supervision the men might not have much floor to take up in order to rectify the level. Another point was to see that the true dimensions of the level were maintained at so many feet high and wide, and a third important point was to keep in view the real vein on which they were driving, as the miners had a tendency to turn aside, and follow the easiest ground to them. In some districts the custom was to let out the work by a sort of public auction or setting, which had the advantage of having everything aboveboard. The men were acquainted with the ground to be worked, and competition was invited, and thrown open, not only to those already employed, but to any other workmen who might wish to compete. The agent, of course, had inspected the place beforehand, and made himself well acquainted with the nature of the ground to be worked. The bidders did the same, and when they assembled a sort of Dutch auction ensued. One man offered to take the work at (say) 12*l.* per ton, another 10*l.* per ton, and so on until the agent thought a fair price was offered, when he threw down a pebble, and the bargain was made. The men who made these bargains often arranged with three or five others to join them, and the system was considered so fair to both sides that it seldom happened that any work was undertaken in which the bargain was not fairly and fully carried out. The very uncertainty which attended the work seemed to give it an attraction in the eyes of the men. Thus, a party might have arranged to be paid 9*l.*, and after driving a little way might find the ground so much softer that it could have been taken advantageously at 6*l.* In such cases the men either took it quietly for the rest of their time, gaining mere ordinary wages, or they worked vigorously, and made a great deal of money. But the ground was also subject to go against them, and then they had to work very hard, and were very much pushed to "make wages," as a fair earning was called. They, however, went cheerfully on, trusting that the agent, when he found that the ground was really so much worse than was anticipated, would make it right in the next month by giving them some advantage. A good deal of the probability of "making wages" being thus in the workmen's own hands, they looked very narrowly and with great care to the physical conditions presented by the mine, and considered all the probabilities likely to come into play during the time for which the bargain was made. It was often a good plan in sinking a winze to let the men have it in a lump bargain, with the condition that if it were done before a certain time they should have a bonus, or if above that time a proportionate deduction. Of late years, in coal districts, the practice had gained ground of paying by weight, the weighing-machine being so arranged that each tram as it came up was run upon it, and in a rapid way every one was weighed. Under the last Act of Parliament the men could appoint a check-weigher, to see that justice was done them. On the other hand, care must be taken that no slack or dirt was put into the wagons, which weighed heavily, and was unmarketable. In metalliferous mines the system of "tributing" prevailed in many districts, by which men were paid so much out of every pound's worth of ore they raised. The effect of this plan was to stimulate the energies of the miners, and, if they were well supervised, it was advantageous; but, on the other hand, it often led to fraudulent tricks. The miners, as a rule, held it to be no breach of honour or honesty to get an advantage over the captain, and mining engineers and those in authority must be on their guard in dealing with men who in other matters enjoyed the highest reputation for probity. Indeed, the best way to obtain security againt practices of this kind was to employ an old "tributer" to make the bargains. The system, however, in copper, lead, and silver mines had, on the whole, been worked with advantage, and would continue to do so where the captains did their duty as well as they expected the men to do theirs.

LECTURE XXI.—Mr. SMYTH said that a question sometimes arose as to whether excavations made at the surface of the ground should be called quarries or mines. In a great number of instances the opening out of the repositories of useful minerals must commence at the surface, and although miners had no doubt about such cases being the commencement of mines, it was not unfrequent to find the question legally tested by actions in the courts of law, and decisions taken whether such works were properly termed mines or quarries. There were, however, many useful minerals, such as building stone and slate, which were worked entirely open to the sky, but these difficulties arose when the workings left the open and penetrated underground, so that the use of artificial light became necessary. In commencing operations on beds of coal, or bands of ironstone, it was sometimes more convenient to begin with an open working rather than by sinking a shaft; and in earlier times this was done more frequently than now. The general commencement of open workings was the removal of the superficial material—the vegetable soil or drift—which formed the surface, and then the removal of the over-burden, or what was called "the top." This was sometimes a work of enormous magnitude, and must be dependent upon the expense and facility of carrying it out, and the results expected to follow. It was generally performed by ordinary labourers, although it required a knowledge of engineering to carry it out with due economy. A great deal depended upon the dip of the ore, as if it dipped into the hill the expense would be greatly increased, and it would be better generally in such a case to run an adit, as otherwise the water would constantly accumulate on the face of the workings. When the top consisted of valuable agricultural ground it must be removed to a point from which it might be easily replaced, when the mineral sought for having been obtained the space was filled up as the work went on. Care, also, should be taken to arrange the roads from the surface to the bottom, whether a steam-engine was used or not. It was not safe, as a rule, to carry on with a large amount of face. Quarry work would sooner or later come to a point at which it was a question whether it would not be cheaper to give up the removal of the overburden, and carry on the works underground. This was frequently the case with building and ironstone; and no finer example could be found than the works adjoining the Box Tunnel, where Bath stone was obtained upon a system similar to the pillar and stall working of collieries. Abroad, the system of working quarries by steps was extensively practised. In France, Hungary, and the South of Europe, and near Pesth, enormous blocks of stone were obtained in this way; but in this country the most notable examples of such workings on a large scale were the slate quarries in Cornwall and Wales. It was extremely important in all these workings that a good system should be laid down from the first, as otherwise the most serious losses might be sustained by the owners. There were cases in North Wales where, for want of proper plans at the outset, adventurers had crippled themselves for many years before reaching the best material. The Welsh quarries were carried on with very little reference to the line of the beds, but chiefly with regard to cleavage. The slabs ranged from a moderate inclination to a position nearly vertical, and the slate was worked parallel to those faces rather than parallel to the beds. The quality of these slates varied considerably. Sometimes there were beds hundreds of feet thick, resembling good slate, which was not so really; and, where it did not look very useful to the inexperienced eye, it might prove to be of an excellent quality. This was of the greatest importance, as there were whole mountains of slaty rock which contained little beyond a kind of slate commercially of very little value indeed. Having, however, surmounted these difficulties, and fixed on a suitable place for the quarry, the position of the planes of cleavage became of importance, as it was this which would regulate the form of a quarry. The quarries at Festiniog, in Merionethshire, were a very good illustration. These quarries produced a blue slate, famous for splitting thin and evenly. One of the accessories to it was a tunnel through the hill, by which means the water was got rid of. The slate, which dipped downwards, was covered with a mass of valueless slaty rock, and a kind of greenstone; and up to a certain point this was removed bodily. After a time this was found to be impossible, and then parallel openings were driven into the rock, and a good portion was worked out by means of underground chambers. This plan, however, was not so advantageous as open-air workings, as the ground could not be excavated with the same economy, and it was necessary to break up the slate blocks into smaller and shorter pieces. Where the cleavage of the slate was vertical, great care must be exercised, or the danger to the workmen would be very great. The quarries were often carried down more than 200 feet, and in such cases there was a constant tendency in the slate to exfoliate and break away in great masses. This was avoided at the Penrhyn Quarries, near Bangor, and elsewhere, by cutting the rock away in steps. At Penrhyn there were 12 or 14 of those steps, wide enough to allow between 3000 and 4000 men to work at one time. In beginning a quarry, if it were on a hill side, where workable slate was to be met with, it was desirable to get the steps into a semi-circular form, or, at any rate, in several different directions, so as to allow of the employment of a great number of men at the same time, and to admit of the over-top being got rid of in the easiest and most economical manner. It was most important to arrange these steps in a proper way, so as to allow of the best disposal of the rubbish, and the most convenient mode of conveying the slate out of the quarry. These steps should not be too elevated, as a fall from any considerable height would damage the slate; and, with a view to avoiding this danger, the steps in the French quarry at Angers were seldom more in height than 10 English feet. On the Continent there were several remarkable examples of gigantic open workings for metalliferous deposits. Good examples were afforded at Fahlun, north of Stockholm, Dannemora, &c., some of which were from 200 ft. to 300 ft. deep in mineral deposits. In the Parys Mountain Copper Mines, in Anglesey (a case analogous to that of Fahlun), this system was worked successfully as late as in the last century. It was accompanied by frightful-looking fissures, and seemed as though if the supports were removed it would fall in bodily; and, indeed, it could not be worked beyond a certain point so safely as by shafts and galleries under cover. It was very important to recollect that there was a limit beyond which such workings could not be carried on with safety. That limit depended much upon the hardness of the material; and even in hard slate, when several hundred feet down, there was a constant risk of fall, which ought to engage the attention of everyone concerned in the direction of such works.

LECTURE XXII.—In passing from the consideration of works on the surface to subterranean excavations, one of the first things to be regarded was the mode in which the workmen were to be lighted in their passage to and from, and at, their work. In some wild and less civilised parts of the Continent, where the excavations reached no great depth, pine torches were employed to this day, a primitive mode of lighting, which, even in such countries, was gradually dying out. The chief material used was tallow, in the shape of candles, whale oil, or rock oil, and petroleum; and the kinds of lamps and contrivances used for burning these materials were extremely various. The most important were those employed when the nature of the atmosphere rendered it explosive, and then the question passed from mere economy to one of the deepest moment to everyone connected with mining. When ordinary tallow candles were used, the differences were chiefly as to the point of size. In some few regions where the air was still, as in the iron mines of the South of Europe, six to the pound was the dimension mostly adopted. In the metalliferous mines from 12 to 20 to the pound was the usual size; but different candles were used for different purposes. Thus, while the men made shift with a comparatively small candle, the captain required a greater light to render his supervision effective, and the larger sized were, from that circumstance, called "captains' candles." In collieries they were often from 20 to 30 to the pound, and it was but a few years ago since they were used to protect the miners from explosions, by observing the effect of the dangerous gases upon the flame of candles of an extremely small size—from 40 to 50 to the pound. That system had entirely passed away, because comparatively unskilful men could now readily detect the presence of explosive gases by the safety-lamp. The candle-test required men of unfaltering hand and abundant courage. The candle was held in one hand, and the other hand was placed between the observer and the flame, so as just to hide the latter from the range of sight. It was then advanced higher and higher, and in case of there being gas its presence was indicated by an elongation of the flame, which raised its top above the

screening hand. There was also change of colour, for, according to the quantity of fire-damp, it became blue as well as elongated. The greatest care was necessary in such cases, for a wave of the air or drawing the flame down too rapidly might cause an explosion. The custom, therefore, now was to use the safety-lamp to test suspicious localities the same phenomena of elongation and change of colour occurring within the lamp without danger of any serious explosion. Persons unacquainted with mining often expressed surprise that, as the use of candles and open lights was so much more dangerous than lamps, the former should be employed; but the fact was that candles possessed considerable advantages over lamps. They gave a larger amount of light, were more readily handled, could be easily fixed in places where they would not be likely to be overthrown, by the simple expedient of putting the end into a lump of well-tempered clay, and sticking that against the wall.

In deep metalliferous mines, however, the height of the temperature rendered the use of candles objectionable, and then lamps in which oil of various kinds and sometimes tallow were burnt, came into play. In shape lamps were as various as the places from which they were brought, ranging from the classic forms of Greece and Rome to the rude clay vessels used in Cornwall; and in the Museum upstairs they would find an extensive and various collection, including almost every form and date of construction. As in mines there were always great draughts or currents of air, the mode of carrying lights was of some importance. In Mexico and Saxony the candle was placed in an open box, to prevent it from being wasted by draughts, with a reflector of metal, kept bright and clean, and suspended from the neck, the box sometimes having a glass front. Oil lamps were generally so shaped that they might be attached to a piece of timber or wall, as near as possible to the point at which the miners were driving, and both lamps and candles were often fixed on a pointed piece of wood, which could be driven into the side of the level or working. In some districts they were made with a spring attached, so that they might be fixed in the hat when both hands were wanted for use. The lecturer then described a few of the principal sorts of lamps with open lights which were employed both at home and abroad (specimens shown) in mines where there was no danger from inflammable gases. The cheapest were those of the Scotch miners, which cost about 2½d. a piece, and would burn from two to three hours for 1d. Mr. Smyth then passed on to the important subject of safety-lamps, the details respecting which were so numerous that if gone through they would occupy several lectures. He would, therefore, only refer to those lamps which had been found the most practical and valuable. When the quantity of fire-damp was but small it might fairly be dealt with by ventilation, and there was no occasion to use the safety-lamp, except for exploring old workings, or where there were blowers. The lecturer then described the Davy lamp, and the circumstances which led to its invention, the modification of it by Stephenson, and the lamp also of Dr. Clanny. These lamps ensured safety if they were always in perfect order, but they required to be used with care and intelligence. For instance, if a Davy lamp were tilted to one side, and left so till the gauze wire became red-hot, there was no longer any degree of security with it. The great objection to the Davy lamp was the smallness of its illuminating power, so that the men were tempted to unscrew the cover, and gain the advantage for their work of an open light. This was conjectured to be the cause of a vast majority of the explosions which were continually taking place. The Stephenson lamp, which differed only from the Davy in having a glass cylinder within the gauze, and the larger amount of light it gave out, was much used, and was called by the workmen "the Geordie." It was urged against "the Geordie" that the glass was liable to break, and that there was great risk of explosion, but in actual use the number of cases of breakage were extremely few. Dr. Clanny's lamp was an exceedingly good one, although there were objections to it also: and there were other good, though less used, modifications of the Davy, amongst which that of Mr. Byron, late the agent of Lord Fitzwilliam, might be specially mentioned as producing by parabolic reflectors an admirable light. It was, however, rather too slight in its construction. But the whole series of lamps, however good their construction, would, even if they were faultless, be insufficient to ensure safety, unless they were locked or secured, so that the workman could not get at the naked flame. Many contrivances had been tried to obviate this difficulty. In Belgium they had a lamp in which unscrewing the cover would put out the light, but that might be evaded by inserting a pin through the gauze. One of the best of these contrivances was that of M. Dubruiller, the effect of which was that any tampering with the cover would draw down the wick, so that the light must be put out. Another good one was that of M. Mueseler, much used in Belgium, of which there were 24,000 at work every day in the collieries of that country. It was a lamp which gave a good quantity of light, and thus took away much of the temptation to unscrew the guaze, which a gloomier light produced. When exposed, however, to a rapid current of air (say) of about 8 or 9 ft. per second, this lamp, in common with those of Davy and others, was not secure. It was, however, a good lamp, as indeed were all the four permitted by the authorities to be used in Belgium. Several good safety-lamps were also due to French inventors; but Dr. Peraira, by numerous and conclusive experiments, had proved that, with every contrivance and with every guard that science or ingenuity had yet suggested, absolute safety had not been secured; for putting aside the carelessness and tricks of the workmen, the protective power of gauze did not exist in currents of air of an ascertained rapidity. Thus, there was danger if the person carrying the lamp happened to stumble; or if the lamp were swung. During the last few years a committee of coalviewers had made many experiments on this subject, which had resulted in the corroboration of the fact that no lamp was safe if exposed to a current of air of 8 ft. per second. For these and other interesting details the lecturer referred to several modern works, and amongst others to a little book of his own, published last year, on "Coal and Coal Mining."

PEAT FUEL, AND ITS MANUFACTURE.

The proposition made at the recent meeting of the Institution of Civil Engineers, in Ireland, that Government, with the view to ameliorate the condition of Ireland, should undertake the utilisation of the peat bogs in that country, has attracted considerable attention, although there are some who consider that the plan there suggested would be open to several practical objections. In consequence of this opinion, Mr. WILLIAM ELSAM, the late manager of the Blaen Pelenna Peat Charcoal Works, Neath, has undertake to demonstrate how that very desirable object—the successful and profitable development of the business of peat manufacture can be attained. If peat can be utilised in such a manner as to give it a real commercial value, it requires no argument to prove that it would occupy a similar position to that of the coal fields and fisheries. Years ago the subject occupied the attention of highly competent parties, and in the year 1846 a most extended and benevolent scheme for employing the destitute population of Ireland in the preparation of peat was organised, a large capital raised, and liberal profits promised by the projectors; but although a superior article was produced, and very valuable products obtained, the processes were found far too costly to be at all profitable, and the great notoriety which this project obtained, coupled with its subsequent failure, has done more than anything else to make the efforts to utilise peat extremely unpopular.

The real question is—Can peat be made to pay? Can our peat bogs, or mountains, or mosses, or by whatever other name they may be called, according to the locality in which they are found, be rendered as valuable, because as easily and economically converted into money as our coal fields or other vegetable and mineral deposits? A host of experiments in all parts of the globe have demonstrated most conclusively that the value of peat in a manufactured or condensed form, either as fuel or charcoal, in a country like our own, where a superior quality of iron is so highly important, far exceeds the most sanguine expectation; but this knowledge is rendered quite useless if the cost of production is such as to impose a preventive tax upon it as regards all practical purposes; many other things equally, if not more, valuable are well known to science; but, unless it can be shown that the cost of production would leave a reasonable ground for the hope of a margin of profit, it would be useless to introduce such projects to the notice of the commercial world. In the New World peat companies and private undertakings are in full and profitable operation, though the country abounds with wood, and peat has been known and valued as a fuel in the Old World at least 700 years, and was used at Freiberg for smelting iron as early as 1560. It is now considered that at some day not far distant, instead of exporting our iron to Canada and the United States, all the vast fields of iron ore now lying dormant in the former country, owing to the want of coal, will, by energy and enterprise, and through the agency of peat, be brought into full and profitable working, and England may be compelled to exchange the position of sellers for that of buyers.

The deposits of peat in Great Britain and Ireland are estimated to occupy an area of not less than 6,000,000 acres; the thickness varies considerably in different localities, from 2 to 30 feet; assuming therefore the average to be 12 feet, an acre would yield about 12,000 tons, equal to at the least nine thousand millions of tons of dried peat fuel. True peat comes from the growth of mosses or grasses of the genus *Sphagnum*, which have the peculiar property of continually growing at the top while laying at the roots, by which process basins upon elevated ground have been in course of time filled up; the surface or top strata of such a peat deposit is generally very fibrous, and affords fuel of such a light and spongy character that, although highly combustible, it is too light to be serviceable when great heat is required; a fire made of such peat may be compared to that of a more condensed character, as brushwood compares with the solid substance of the tree. From the ease with which such peat is cut and dried in peat districts, a character has been acquired for peat, implied by its name "turf," which is not a really true one. The lower we get in digging peat, the more decomposed and black it becomes, until at the depth of 5 to 6 feet, it loses apparently almost entirely its fibrous character, and looks like mere black mud; this, however, upon a close examination with the microscope, will be found not to be the case, but that, on the contrary, this fibrous character is rather rendered more perfect by decomposition and compression; for in this state it will be found much more difficult to rid it of the water and air contained in these minute vessels. It is when the peat is mixed up in these different stages of decomposition, and its spongy nature destroyed, that it forms the best fuel when properly dried and condensed. A peat deposit can easily be examined by a boring instrument, to ascertain its depth; and in order to test its value commercially, each foot as brought up should be carefully tested by maceration, to determine the sediment or earthy matter contained in it, and by burning after being dried, to test its value as a fuel, and the quantity of ash, &c. Upon such a careful examination many deposits that to the eye seem everything that could be desired will be found to contain much earthy matter, and, therefore, to be of less value to work.

The value of peat when properly condensed and dried is considerable upon many accounts, but chiefly from the fact that there is scarcely a trace of either sulphur or phosphorus to be found in it. The elements of peat are essentially those of wood and coal, as shown by distillation; for it yields ammonia, acetic and pyroxylic acids, tar, naphtha, oils, and paraffin in greater or smaller proportions, according to the nature of the peat operated upon. The purposes to which peat fuel can be applied are as various as those of wood or coal, and it answers all the requirements of a perfect fuel more economically than either. For domestic purposes it is preferable to coal wherever the cost is the same, and in Canada it has been successfully employed in iron making. At the Caledonia Works, Montreal, experiments have been made by melting iron with peat fuel, mixed with coal, and it was found that the charge melted in 40 minutes less time than with coal only; the castings made from the iron were more dense, and, of course, much stronger; it was all taken at a high price by a firm for making railway carriage wheels. A round bar, 10 in. long, ⅝ths inch diameter, was coiled, when cold, into a ring of 3 in. diameter; while another piece was drawn out, when cold, with a hammer, in such a manner as very few qualities of even wrought-iron would stand. The amount of limestone required was much less, and owing to the more intense heat the iron made faster, thus showing a saving of fully 25 per cent. over either charcoal or anthracite. The experiment lasted three weeks, and was made in the presence of many of the largest iron proprietors, who unanimously pronounced the iron made to be equal, if not superior, to any iron they ever saw. The applicability of peat to the generation of steam has been so frequently discussed, that it is unnecessary to refer to it; and with regard to its value for the manufacture of gas, Mr. VERSMANN, of the Commercial Gas Company, states that a ton of best air-dried peat, the specific gravity of which was ·810, and containing ·93 per cent. of moisture, yielded 13,160 cubic feet of gas, equal to 16¼ sperm candles, and he observes that the only true obstacles to the permanent application of peat for gas purposes are completely removed by the process of condensation now adopted, which in a simple and most efficient manner produces a peat containing considerably less water than coal, and the coke obtained from it is of the most dense and compact nature, resembling much more wood charcoal in its outward appearance and its properties than common coke. He considers the process of condensation of the utmost importance, and that it will, at no distant time, materially influence the art of gas manufacture: by the introduction of peat into gasworks a considerable saving must be effected.

As to the method and cost of making peat fuel, it has been very justly observed that it is the fixed water, that which cannot be squeezed out, artificially dried out, nor hastily evaporated by sunshine and wind, that constitutes the great difficulty; every attempt to squeeze out this fixed water by pressure has failed, and always will fail, from physical causes which cannot be overcome, so long as the peat retains its natural state, for the fibrous vessels not only contain water but air. Peat in its natural state will never become really dry; the so-called dried peat containing from 15 to 25 per cent. of water, and being at all times liable to imbibe moisture from the atmosphere; the first step must, therefore, be to change its state, as was done by the machines of Mr. BUCKLAND and Mr. LEAVITT. The locality or position of the bog should, of course, be chosen with judgment, in reference to a market for the intended produce, carriage being a very important item, especially if fuel only is intended, and, this being decided, the works should be placed at the lowest part of the bog, so that the crude material can be worked down hill or upon a level, which is, perhaps, quite as economical. After the part of the bog intended to be cut has been properly drained, the surface peat removed and laid up to dry for consumption on the works, the process may be carried on somewhat in the following manner:—Under a stretched rick cloth, two men will throw upon a temporary stage, raised about 1 foot from the ground, to admit of drainage, about 100 tons per day; this, if allowed to remain a few days before transportation to the works, will, especially if kept under such a cheap form of cover as described, lose a considerable portion of its moisture; it is then put into trams for conveyance to the mill, which trams are provided with a simple screw to press out any moisture it may have taken after being dug. By this means from 25 to 30 per cent. of the moisture is got rid of before the peat is put into the mill. A plan has been devised which, by the application of a suction-pipe, worked by the engine, absorbs a still further portion of the moisture, the getting rid of which by every possible means is, of course, all important as a question of cost. The peat is then tipped into the mill, to which reference has already been made; this mill is made double cased, and heated by a jet of steam from the engine, the peat is, therefore, warm in passing, and is then passed over one or two endless bands after moulding, which bands are confined in a small heated chamber, falling finally upon a bottom band, which conveys them into the shed along a flue, or rather above a flue heated by hot air; this flue or walled road is so arranged that, with the smallest possible amount of labour, the 60 tons, reduced now to at least 40, which is taken as a basis for one mill's work, can be so placed as to remain over the flue, and in twelve hours become so dry that they can safely be thrown about, and are then, by light portable trucks, conveyed and stacked for use in the shed. The construction of this shed is of great importance, heated moderately by flues, and the roof on each side coming almost close to the ground; with ventilation at the top a quick draft is produced of dry air, and this in drying peat is of more importance than great heat; experience has proved that a dry cold air will effect the purpose quite as well as hot, but in our humid atmosphere, and especially in peat localities, which of themselves indicate moisture, this is not to be obtained.

The plant for carrying out this plan would cost about 2000*l.* for one mill; such mill being capable of making 60 tons of wet or 13 tons of dried peat per day. This amount includes the erection of a shed of galvanised iron, which is considered to be the most economical; but at least 500*l.* could be saved on this item if timber and felt were adopted, and of course locality would make a great difference in the cost, but the above estimate would under ordinary circumstances cover the outlay in any position. The cost of labour, coals, and wear and tear of machinery upon a make of 60 tons of crude peat would be about 54s., or say 4s. per ton of dried peat fuel produced. As to the probable profit and loss, the knowledge of the precise details of each particular case would be required before an estimate could be made. When good thoroughly dried and seasoned peat fuel is obtained, the converting of that into excellent charcoal is no more difficult than in the case of wood or coal-coke. The reason why wood, coal, or peat is made into coke is not to increase the quality, but the quantity of heat derived from a given quantity of fuel—in fact, to concentrate the melting point as we concentrate the sun's rays in a burning glass. We may have abundance of light wood or brush capable of making a great blaze, but if we want concentrated heat we must use concentrated fuel. It requires more care and judgment to be exercised in the production of peat charcoal than in making of the fuel, but all special difficulties as relating to the utilisation of peat are overcome when the condensed dry fuel is obtained in such quantities, and at such a price, as will pay for the manufacture. The method of coking the fuel may vary, and will always do so, from a variety of causes; much will depend upon the analysis of the fuel intended to be worked upon, and if it is desired to secure any of the other products of the peat during the distillation; in all cases where manufacturers are in the habit of making their own charcoal, they can do so with equal ease by simply purchasing the peat fuel to operate upon instead of wood; there would be no more difficulty or difference in the process than an experienced charcoal burner now finds to exist in the treatment to be given to the different qualities of wood. It is estimated that the charcoal would cost about 20s. per ton, and would readily sell at from 50s. to 60s. Of the grease and other by-products no account is taken in this estimate, although some or them could, no doubt, be utilised.

The cost of plant to make 10 tons of charcoal per week could not, including buildings, exceed 700*l.* Each bed of retorts should, to work it properly, and allow time for the charcoal to become extinguished, without the application of artificial means (which, in all cases, must injure the quality), be provided with (say) six wrought or cast iron extinguishers, at a cost of about 6*l.* each, and one iron trolly to carry them away. These, with all the needful irons for working the retorts and fires, would be more than covered by an allowance of 150*l.*; yet this would only raise the total to 675*l.* It is considered that a work of this size, if attached to tin or other manufacturing premises, would, without further cost, produce a sufficient supply of gas to light up the whole establishment, and it is, therefore, a question well worth consideration if, in many cases, the coking of the fuel would not be more economically conducted by the consumers of the charcoal; and, on the other hand, if it would not prove more satisfactory and profitable to those working peat to rest satisfied with the simple manufacture and sale of fuel, leaving to gasworks, large consumers, or chemical works, who could utilise the various products, to convert the fuel into charcoal. It is believed that from these remarks some conclusion may be arrived at as to whether peat can be condensed by a process sufficiently simple and inexpensive to render it commercially available for practical use. The estimate which Mr. ELSAM has given as the cost of plant is for the manufacture continuously and in such quantities as would be required in cases where a business was made of it; but under other circumstances this estimate could be greatly reduced, and when, as in the case of manufacturing firms or private individuals, the quantity required would be known and time allowed. The cost of plant need not exceed that of the simple price of the mill, which could be made portable, to fix near the peat, and to be worked either by portable steam-power, in most districts to be hired, or by horses, like an ordinary threshing machine. In those districts where peat is found, and coal is not to be obtained under 10s. per ton, Mr. ELSAM considers there can be no question but that all manufactories requiring steam-power—breweries and similar establishments—would find the manufacture of condensed peat fuel, for their own consumption even, to be very advantageous.

SILVER SMELTING IN COLORADO.

THE TERRACE FURNACE.

In the process of matt-smelting, now adopted in Colorado, it is not directly necessary to produce a complete desulphurisation. But, it is vitally important that the smelter should perfectly control his work, knowing precisely, at any stage, the proportions in which the various elements of his charges are mixed, and adding, at the right time, the right substances in the right quantity. Desulphurisation, therefore, should be uniform, if not complete; and, perhaps, the best way to attain this result is to perfectly desulphurise, or "roast dead," a part of the ores, and then add, for the matt-smelting, a sufficient quantity of the crude material. For the information of non-professional readers, we will add that a matt is an artificial sulphuret, containing much less sulphur, and much more metal, than the natural ore. Matt-smelting is, therefore, a concentration of the valuable contents of an ore into a new artificial one. The preparatory removal of the excess of sulphur is accomplished by roasting, in heaps, kilns, or furnaces. An exact control of the process is only possible in furnaces; but they have the disadvantage of requiring a previous pulverisation of the ore. Whether an engineer should choose an imperfect "kernel-roasting" in heaps or kilns, or a complete and careful roasting in furnaces, is a question depending upon the charactor of his material, the nature and number of the metals he desires to extract, and the price of labour and fuel. We do not undertake to give any sweeping general answer to it; but it is our impression that the circumstances of the special case before us require careful roasting in furnaces.

The Terrace Furnace is a substitute for the reverberatory. The latter is liable to the following objections: first, the necessity of a continual, or at least frequent, stirring of the charge, to expose all parts of it to the oxidising influence of the air, and to prevent it from sintering; second, the dependence of the result upon the skill and faithfulness of the workmen, and its lack of uniformity, even when they do their best; third, the long time required to change the temperature of the furnace, which may involve a sintering of the charge, on the one hand, or a delay in the process, on the other; fourth, the necessity of employing, when the sulphurous fumes of the roasting are to be utilised in the production of sulphuric acid, muffle furnaces, which not only consume too much fuel, but in the use of which the sulphurous acid is produced in fluctuating proportions at different periods of the process, and considerably diluted with excess of air. All these evils, heretofore considered unavoidable, are obviated in the Terrace Furnace, the construction of which is the following.

A shaft-furnace, 20 ft. high, and 4 ft. by 2½ ft. internally, is closed at the top by an arch. The pulverised dry ore is charged by means of grooved rollers through a hopper and a slit in the arch, 2½ ft. by 2½ in., parallel with the shorter side of the furnace, into the roasting chamber. This feeding arrangement is such that, when the rollers are still, no ore can enter the furnace, while an increase in the speed of revolution of the rollers augments the quantity of ore charged, and, as will be seen, elevates the temperature in the furnace.

The free fall of the ore in the furnace is hindered by a series of shelves, or terraces, extending from the front to the rear wall, and consisting of equilateral triangular prisms of fire-clay, 5 in. in width, and lying with one side horizontal and uppermost. This form is given for the sake of strength; the essential thing is the upper surface, upon which the ore falls. The first terrace is directly under the feed-slit; and upon this the ore accumulates, until it reaches its natural *talus*, which differs, of course, for different material and fineness. Eight inches lower are placed two terraces, in such a manner as to receive the ore, sliding from the first, on both sides. Upon these the ore again accumulates, and slides again to the third series, consisting of three terraces. Below these are 15 successive series, alternately of six and seven terraces, so that the whole number in the furnace amounts to 103. The ore glides constantly from one terrace to another, and remains, by virtue of this hindrance to an accelerated fall, seven or eight seconds in motion, exposed in a finely divided form, and under the most favourable conditions, to the oxidising influence of the air. The greater part of the sulphur is removed by its own combustion during this period; and, according to the recent experiments of GERSTENHOFER in Freiberg, confirmed by the judgment of BRUNO KERL, the addition of six more series of terraces secures a uniform and perfect "dead roast." In this enlarged form, therefore, the furnace would be applicable in association with an amalgamating process. Since the whole charge, with the exception of a small quantity accumulated upon each terrace, is constantly in motion, and the quantity in every part of the furnace is the same, the temperature of the interior (which depends entirely upon the combustion of the sulphur in the ore) is uniform throughout, and can be regulated at will by changing the rate of draught, and the speed of the revolving feed-rollers. The services of a single workman are more than sufficient for tending the furnace; and the result of the roasting is, in a high degree, indipendent of his attention. When the furnace is once in operation, and the proper rate of feed and draught has been determined by experience, it will run for a long time without fuel and without interruption. The "campaigns" in Swansea, Freiberg, and Mansfeld last from 1½ to 2 years. The daily charge of ore depends upon the quantity of sulphur it contains. Ores rich in sulphur cannot be so rapidly fed as the poorer ones, on account of the consequent rise in temperature. In other words, the capacity of the furnace must be measured in sulphur, not in ore. In Freiberg, from 5 to 6 tons of crude sulphurets are roasted in each furnace every 24 hours; while in Mansfeld, where copper matt, containing less sulphur, is roasted, the daily capacity is 10 tons.—*Scientific American.*

CALIFORNIA MINING MACHINERY FOR NICARAGUA.—The Union Foundry has just completed a 10-stamp quartz mill, with amalgamating machinery (such as is generally used in Grass Valley) complete, which will be shipped on the next Nicaragua steamer for the Javali Mine, in the Chontales mining district, near the town of Libertad, and about 50 miles east of the most northerly point of Lake Nicaragua. This mine belongs to an English company, whose head-quarters are in London; they have given their orders for machinery here, for the reason that they think a better character of gold-mining machinery can be furnished from the foundries in this city than would be obtained from English foundries. The Chontales mining district yields both gold and silver ores. It was first made known to the world about two years after the gold discovery in this State. But little, however, has been done until quite recently in opening the mines. There are as yet only two or three mills in operation there, one of which belongs to an American, named George King, who has just put up a steam mill, the engine and machinery for the same having been brought out from New York. The Javali Company's mill will be run by water, as they have a good water power convenient to the mine. No deep mining has yet been done; the quartz, which is of a friable nature, being worked directly from the surface. The general average, so far, has been about $16 to the ton, which, counting the low price of labour there, and the small cost of mining—the veins being large—is good pay. There is a fair prospect that a valuable mining district will be eventually opened up there. As yet but little is known of its extent. We are not aware that any placer mines have yet been found. Ready communication might be opened with the mines by a road, not over 50 miles in extent, connecting with the navigable waters of Lake Nicaragua. Should extensive mines be opened there, they will probably be supplied with machinery chiefly from here. The machinery, about to be sent down from the Union Foundry, will no doubt present such a favourable contrast with that heretofore used as to determine all future purchases from this point.—*San Francisco Mining and Scientific Press.*

CAST-IRON WATER-PIPES FOR ABYSSINIA.—Three weeks ago a telegram was received from the Abyssinian expedition for 18 miles of cast-iron water-pipes, intended to convey water from the bottom of the Koomalo Pass to Zoula. The first shipload has already sailed from Liverpool. The order for them was distributed amongst the following firms:—Messrs. D. Y. Stewart and Co.; Messrs. Edington and Co., of Glasgow; Messrs. Cochrane and Co., of Middlesborough; and the Staveley Iron Company, in Derbyshire. The pipes are each 4 in. in internal diameter, 12-32 in. thick, and 9 ft. 3 in. in extreme length, giving 9 ft. clear when fitted; they are all supplied with bored and turned joints. Each pipe weighs about 1½ cwt., and is calculated to resist a pressure of 400 ft. The head to which it will be subjected is only 170 ft. As showing the resources of the Ormesby Foundry (Cochrane and Co.), we may mention that the five miles supplied by this firm were completed in three weeks.—*Iron Trade Review.*

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